Laminoplasty/Foraminotomy: “Why Fuse the Spine at all?”

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CERVICAL FORAMINOTOMY
(The other motion sparing procedure)

- ADVANTAGES?
  - NO FUSION
  - LESS ADJACENT SEGMENT DEGENERATION
  - MINIMAL POTENTIAL FOR INSTABILITY
  - CAN ADDRESS DISC AND SPUR

Disclosures
- Medtronic: Consultant, Royalties, Patents
- Biomet: Consultant, Royalties, Patents
- Globus: Educational Consultant
- Nuvasive: Consultant, Patents, Royalties
- K2M: Educational Consultant
- Stryker: Educational Consultant
- NIH: Research Grant
- Department of Defense: Research Grant
- NATCN: Research Grant
- AO: Research Grant
- AO: Fellowship support
- NREF: Fellowship support

Zeldman and Ducker reviewed 172 patients
- 167 (97%) had relief of pain

Foraminotomy + discectomy for motor weakness, 36 of 39 (93%) regained normal function

One patient with post-op central cord syndrome

**Outpatient Foraminotomy**

- Tomaras and associates reviewed 200 patients with follow-up on 183 (mean f/u 19 months).
- Non-worker’s compensation patients had 93% “good” or “excellent” outcome.
- Worker’s compensation patients had 78% “good” or “excellent” outcome.


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**Laminoforaminotomy for Disc Herniation and Radiculopathy**

- Woertgen and associates reviewed 54 patients.
- At 1-year follow-up, 94% showed improvement or complete recovery.
- Recommended early treatment.


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**Laminoforaminotomy**

- UVA retrospective review of prospective database.
- 162 patients treated using the posterior cervical foraminotomy including partial facetectomy.
- Minimum 5-year clinical and radiographic follow-up.


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**Laminoforaminotomy**

- Resolution of radiculopathy was experienced in 104 patients (95% of patients with radiculopathy).
- Mean presenting NDI Score was 18 (Range, 2-39).
- Mean post-operative NDI score was 8 (Range, 0-39).
- Post-operative instability on dynamic imaging was present in 8 patients (4.9%).
- Post-operative loss of lordosis was seen following 30 patients (20%).
- Vast majority asymptomatic.


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**Laminoforaminotomy**

- 5 patients (5.6%) required a total of 9 additional cervical spine operations.
- 2 cases this was due to disk degeneration at the previously operated level (treated with ACDF).
- 2 cases required surgery at adjacent segments (treated with additional posterior surgery).


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**Tandem Keyhole Foraminotomies**

- 97% resolution of radicular pain.
- Small percentage took longer than 6 months for its resolution.
- Longer f/u needed for effect on stability.

Muscle dissection

Often epidural bleeding

More postoperative neck spasm and pain

Disadvantages:

Microendoscopic Foraminotomy (MEF)
Microendoscopic Discectomy (MED)

MIS Surgical Technique

MIS vs. Open Foraminotomy

Fessler et al. treated 25 patients MIS and 26 open
Radiculopathy resolved in 54%, improved in 38% in MIS group (92% overall)
Radiculopathy resolved in 48%, improved in 40% in open group (88% overall)
Overall, outcomes were statistically equivalent


ISSUES?

– INSTABILITY
– EFFICACY
– INFECTIOIN
– CSF LEAK
– ROOT/CORD DAMAGE
– INCREASED REOP RATE

Posterior Cervical Approach: Instability

Panjabi and colleagues:
- Functional spine unit remains stable if:
  - All anterior elements intact
  - One facet remains intact

Ulrich and coworkers:
- Flexion stability preserved when:
  - Posterior ligamentous elements are intact
  - Despite extensive facetectomy

Zdeblick and colleagues:
- In vitro study showed instability if:
  - >50% of facet removed

Panjabi et al J Biomech 8:327–336, 1975
**Posterior Cervical Approach: UVA Series**

- 973 posterior cervical hemilaminectomies between 1993-2008
- 162 patients with follow-up of 5 years or more retrospectively analyzed
- Radiculopathy resolved in 95%
- No significant trend towards kyphosis in spite of extensive facetectomy and pedicle drilling


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**Cervical Spine: Anterior vs Posterior Approach**

- Adjacent level disease
  - More prominent in ACDF: incidence of 2.9% per year
  - Posterolateral foraminotomy and discectomy: annual incidence 1.2%


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**Prospective Studies: ACDF vs. Posterior Foraminotomy**

- Herr kowitz et al Spine 1990
  - 33 patients
  - Good/excellent results 94% anterior vs. 75% posterior
- Korinth et al Spine 2006
  - 292 patients total
  - Good/excellent results 93.8% anterior vs. 85.1% posterior
  - Also overall results better for soft as compared to hard disc for both groups

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**Clinical Study**

Complications, outcomes, and need for fusion after minimally invasive posterior cervical foraminotomy and microdiscectomy

Branko Skovrlj, MD,1 Yukio Gohspony, MD,1 Robert Happ, MD,1
Richard G. Fessler, MD, PhD,1 Shereen A. Oureha, MD2

97 patients with MIS cervical foraminotomy/discectomy

3 (4.0%) complications (1 cerebrospinal fluid leak, 1 postoperative wound hernia, and 1 radiculitis) none of which required a secondary operative intervention. Five patients required an anterior cervical discectomy and fusion (eight total levels fixed) at an average 44.4 months after the index surgery. Of these, three (5.3%) were at the index level and three (2.1%) were at adjacent levels. Neck discomfort was noted in 4 patients at the index level and in 2 at adjacent levels. Neck discomfort was noted in 4 patients at the index level and in 2 at adjacent levels.

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**Long-term patient outcomes after posterior cervical foraminotomy: an analysis of 151 cases**

Clinical article

*Edward H. Bydon, M.D.
“Neural Matrices, M.D.
*"Michael Mack, M.D.
*"Rafael de la Garza-Ruiz, M.D.
*"Dale M. Schultis, M.D.
*"Timothy F. Whitting, M.D.
*"Jean-Paul Wolden, M.D.
*"Ziya L. Gokaslan, M.D.
*"Ali Bydon, M.D.
*
*“The Spinal Column Biomechanics and Surgical Outcomes Laboratory and Department of Neurosurgery, Johns Hopkins Hospital, Baltimore, Maryland

Conclusions: PCI is a procedure performed to address nerve root compression at the cervical spine. The authors evaluated 151 patients who underwent retroptoral PCI and found a reoperation rate of 0.9% at an average of 2.4 years after the initial surgery (6.6% at same level, 3.3% for levels). The reoperation rate was 1.3% and 2.5% in patients with and without preoperative history of PCI and 0.8%, respectively. The authors concluded that patients with central and lateral pain had the lowest rate of reoperation after PCI.

http://dx.doi.org/10.1016/j.spinee.2013.03.013

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**Rates of anterior cervical discectomy and fusion after initial posterior cervical foraminotomy**

Timothy Y. Wang, B.S.,1 Daniel Lubelski, B.A.,1 Kahl G. Abdullah, M.D.,1,2
Michael P. Steinmetz, M.D.1,2,3 Edward C. Benzel, M.D.1,2,3, Thomas E. Moos, M.D.1,2,3

RESULTS: One hundred seventy-eight patients who underwent PCI were reviewed, with an average follow-up of 31.7 months. Nine (5%) patients underwent an ACDF revision operation at the index level. The reasons for reoperation in these patients included central radiculopathy, foraminal stenosis, disc herniation, and cervical stenosis. Patients who subsequently underwent ACDF at the index level were significantly younger (25 vs. 35 years, p = 0.05), had lower body mass index (25 vs. 29, p = 0.03), and more likely to take antiplatelet therapy (56% vs. 22%, p = 0.04) or antidepressant medication (45% vs. 27%, p = 0.02), compared to those that did not have a reoperation. CONCLUSIONS: This is the first study to determine conversion to ACDF after PCI. The present study demonstrates that PCI is associated with a low reoperation rate similar to the historical reoperation rate for ACDF. Accordingly, spine surgeons can operate on a PCI approach without a significant increased risk for ACDF revision surgery at the index level.

**Why Laminoplasty?**
- Maintains motion of instrumented segments
- Reduces biomechanical demands on adjacent segments
- May reduce adjacent segment degeneration
- Reduces post-laminectomy instability
- Reduces post-laminectomy membrane formation
- Lower incidence of complications compared to multilevel corpectomy

**Why Not Laminoplasty?**
- Not indicated if significant kyphosis
- Does not directly address significant anterior pathologic structures
  - Large disc herniation or osteophyte
  - Significant uncinate spurs causing radiculopathy
- Higher incidence of axial neck pain and shoulder pain compared with multilevel corpectomy

**Complications of Laminectomy**
- Post-Laminectomy Deformity
  - Well established in children (>80%)
  - More controversial in adults
    - reportedly 6%-52% incidence
    - Herkowitz Spine 1988
    - 25% incidence in CSM
    - Mikawa Spine 1987
    - 0% incidence in CSM; 11% in OPLL

- Post-Laminectomy Membrane
  - Dorsal scarring + flexion movement
    - compression
  - Breig 1969
  - Slucky NASS 1995
  - Shinomiya CSRS 1995
  - Role of posterior epidural ligament – anchors dura to ligamentum flavum

**Open-Door Laminoplasty**
**Indications**
- Myelopathy or myeloradiculopathy caused by:
  - Congenital cervical canal stenosis
  - Multilevel cervical spondylosis
  - OPLL
- Surgical contraindications
  - Focal severe anterior cord compression
  - Kyphosis
  - Instability

**Post-Laminectomy Membrane**
- Dorsal scarring + flexion movement
  - ? compression
- Breig 1969
- Slucky NASS 1995
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- Role of posterior epidural ligament – anchors dura to ligamentum flavum

**Cervical laminoplasty developments and trends, 2003–2013: a systematic review**
Stephan Duettmann, MD, Tyler Cole, BS, and John K. Ratliff, MD
- 103 studies, the results of which contained at least 1 of the pre-specified outcome variables, were identified comprising 8949 patients
- 4949 patients for whom a JOA score was reported there was improvement from a mean (± SD) score of 9.91 (± 1.65) to a score of 13.68 (± 1.05) after a mean follow-up of 44.18 months (± 35.1 months)

The mean preoperative and postoperative C2–7 angles (2,470 patients) remained stable from 14.17° (± 0.19°) to 13.98° (± 0.19°) of lordosis (average follow-up 39 months).

Significantly decreased kyphosis when muscle/posterior element–sparing techniques were used (p = 0.02).

An overall mean (2,390 patients) of 47.3% loss of range of motion was reported.

Those patients with VAS recorded (986 patients), the postoperative pain level at a mean follow-up of 29 months was 2.78.

% of patients who complained of postoperative axial neck pain (1,249 patients evaluated), the mean percentage was 30% at a mean follow-up of 51 months.

Laminoplasty Techniques

A. Hirabayashi
B. Kurokawa
C. Hardware-augmented Hirabayashi
D. Hardware-augmented Kurokawa
E. Muscle sparing Hirabayashi
F. Muscle sparing Kurokawa

Laminoplasty Results

Compare with Corpectomy


- Equivalent functional recovery LP vs. Corp
- Lower complication rates with LP

Laminoplasty – Controversies

Compared to Laminectomy with Fusion


- Independent matched cohort analysis
- Greater neurological improvement with laminoplasty (1.6 vs 0.9 Nurick grades)
- Fewer complications with laminoplasty
- Less pain medication required at final follow-up with laminoplasty


- Objective [Nurick score] and subjective improvement greater in laminoplasty group
- No complications in laminoplasty group
- Complications in laminectomy + fusion group:
  - Nonunion / hardware failure
  - Sublaminar degeneration

? Can/should do laminectomy w/o fusion?
Systematic review and meta-analysis of cohort studies comparing anterior CORP with posterior LAMP for the treatment of multilevel cervical myelopathy due to CSM or OPLL from 1990 to December 2012.

- CORP and fusion was recommended for the treatment of multilevel cervical myelopathy when the involved <3 surgical segments.
- Neurological recovery was superior in the CORP group compared with the LAMP group when the mean surgical segments were <3, but were similar between the two groups in > or equal to 3.
- Surgical complications and complication-related reoperation and the higher surgical trauma associated with multilevel CORP (especially in >3 segments).

Weighted Mean Difference of Postoperative JOA

<table>
<thead>
<tr>
<th>Study of Reference</th>
<th>Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight</th>
<th>Mean Difference</th>
<th>95% CI of Mean Difference</th>
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<td>Lao et al. 2000</td>
<td>12.3</td>
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<td>10</td>
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<td>20.5</td>
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<td>7.2</td>
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<td>-14.1, 4.1</td>
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<td>11.4</td>
<td>7.8</td>
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Odds Ratio of Reoperation Rates

- Operation time in the CORP group was longer than that in the LAMP group.
- Average blood loss was significantly more in the CORP group compared with the LAMP group.
- There were significantly more reoperations in the CORP group.
Laminoplasty - Controversies

- Increased axial pain / atrophy
  - Excessive dissection / immobilization
    - Fujimura, Acta Orth Trauam Surg 1996
    - Asano, CSRS 1999
    - Heller, Spine 2004

- C5 nerve palsy
  - Reported incidence: 2% - 11%
  - Delayed onset
  - Generally transient

Indications for Fusion

- Instability
- Kyphosis that fails to correct in extension
- Iatrogenic destabilization
- Inflammatory disease
- Severe axial pain?
- Otherwise............. Laminoplasty!